Art. XXXII.—*On η Argûs and Nebula.* By F. Macgeorge.

[Read 9th October, 1871.]

The admirable sketch and description of this wonderful object given by the late Sir John Herschel, and the catalogue of the stars comprised in it, form together—as far as the power of his 18-inch aperture could reach—a complete record of the appearance of η Argûs and Nebula, between the years 1834—1838. In that description he gives the position of certain stars on the borders of the lemniscate or central vacuity, close to the star η, in these words: "Four stars, Nos. 686, 603, 589, and 670 = *w* of the catalogue, are placed precisely on its edges, and will serve as excellent detectors of change in its form, should any occur. The stars No. 607 = *t*, 664 = *v*, and 616, though near the edge, are yet fairly immersed in the Nebula. On the other hand, No. 634, situated in the contraction of the oval towards its middle, is yet fairly within the vacancy, and so situated, that the slightest shifting of the nebulous contour at its preceding side, cannot fail to be rendered sensible." This piece of precise word-painting, added to the evidence of the published engraving in Sir John's Cape observations, is most valuable, since a comparison with the nebula, as seen in 1871, will shew beyond doubt or cavil, the inapplicability of such a description, and such a drawing to the present appearance of the lemniscate outline in the Great Telescope. The rough chalk sketch marked *H*, is a copy from part of the inverted drawing of Herschel, re-inverted to suit ordinary telescopes; and I hope it will be distinctly understood that this and the other five rough copies from the working drawings are the work of one hour, and only intended to shew the salient points and the two or three stars referred to, the rest being unimportant.

From 1838 to 1869 no observations of the nebula around η of a trustworthy character could be made—owing to the want of a telescope of sufficient power—although most interesting and important observations of the star η itself, and of the surrounding stars, have been made with small apertures, and Mr. Tebbutt of New South Wales, in particular, has in the *Astr. Soc. Monthly Notices*, for May last given a list of magnitudes of η Argûs from 1854 to 1870, which

seems to shew that small periodical fluctuations of its light are still in progress, presaging possibly another outburst of this wondrous variable.

Mr. Le Sueur's first glance through the great Telescope at η Argus, in April 1869, revealed important changes, shewn in sketch 1 ; η, which in 1838 was involved in dense nebula, was seen on bare sky—the nebula having disappeared for some distance around it—and the southern loop of the lemniscate, consisting of equally dense nebula in 1838, had grown so faint as almost to disappear. The preceding side of the lemniscate had bulged out into the vacuity and stretched itself out into a bridge or isthmus, which, after a bend towards a projecting cape on the other side which seemed to stretch into the vacuity to meet it, passed northwards and joined the other loop of the lemniscate. The overlying streak or veil alluded to by Herschel, and shewn in his chart, had divided into a V shaped appendage to the *N* end of the *N p* loop of the lemniscate, and in July following, Mr. Le S. notes that a faint bridge existed, joining the *S* end of the isthmus with the nebula on the *f* side, across the vacuous channel.

As η Argûs has no sensible parallax, and in all probability is in physical connection with the nebula, we may assume every second of arc upon the rough drawings supplied, to represent at the least twice the diameter of the earth's orbit, and as each of the sides of the squares shown upon the drawings represents 180 seconds of arc, a rough scale is supplied by which to estimate changes whose magnitude and rapidity have no parallel in astronomic record ; yet these changes as they are followed through their cycle, may remind the observer more or less forcibly of internal changes not very dissimilar, which are so frequently exhibited in sun-spots.

Still more wonderful in its rapidity appears the change represented by Mr. Le S's next drawing of January 1870, only six months later, readily shewn in sketch 2. The isthmus of nebula has detached itself from the north side of the lemniscate, and withdrawn itself through 90 seconds of arc to form a broader peninsula of nebula, with such rapidity, that the severed end of the isthmus would appear to have travelled at a rate, *per month*, of 30 times the diameter of our orbit. These distances are of course estimated at right angles with the visual ray, and the real distances will in all cases be greater, since the various parts

of this nebula are doubtless situated at widely different distances from the observer.

This second sketch of Mr. Le Sueur's contains little else that differs from his first, except that in the corner he makes a memorandum: "Noticed a bridge at + Jan. 31, 70—never sure (?) before—may be small stars." But as he notes on his first sketch: "Bridge at ϕ in channel—no doubt at all—April—July, 1869." The truth probably is that a bridge existed at both these periods, which had been withdrawn in the interval, as my subsequent notes may explain.

Last month, after concluding my year's observations on this nebula—then becoming too low *sub polo* to observe—I unexpectedly came upon a third sketch (No. 3) of Mr. Le Sueur's, among some of his stray papers. Although unfinished—indeed, just commenced—I look upon it as the most valuable of the three, for, so far as it goes, it entirely corroborates the evidence of one change since observed by myself in the nebula, and sketched by me in entire ignorance of this sketch, thus supplying so unexpected yet stringent a link between his observations and mine, that hereafter no suspicion of optical bias as affecting the more important changes observed can enter my mind.

After dotting down on his sketch all the stars observed near η—nearly three times outnumbering Herschel's in that space—which agree entirely with my latest sketch, even to the position of a minute triple star *n f* and close to η shown *double* by H., and *triple*, but *differently placed* in 1871 by Mr. Russel, of Sydney Observatory, Mr. Le Sueur proceeds about March '70, to pencil the outline of the lemniscate, and at 2′ 30″ *p* 1′ *N* of η shews the outline of a gulf or cleft commencing at the star 634 *H*. This star is one of those landmarks described by H. in the year 1838 as being near the margin. Mr. Le Sueur's sketch shows it nearly in mid-channel; 616 *H*, however, being still involved in nebula. Here probably Mr. Le Sueur saw the commencement of the intricate changes since observed by me in the *n p* loop of the lemniscate, and paused to unravel them before proceeding.

In December, 1870, η was again sufficiently high to observe, and I took the first opportunity of turning upon it on the 27th, when, on comparison with Mr. Le Sueur's sketches 1 and 2—for No. 3 had not then been found—showed marked changes in the nebula, and I at once commenced my first sketch, No. 4, confining myself to the neighbourhood of the lemniscate, where the most important changes seemed to

be taking place, and where, from the brightness of the nebula and the amount of varying detail, the best field offered for the powers of the Great Telescope. For the changes of which I have spoken, and those of which I have yet to furnish a description, are utterly beyond the powers of detection of every other instrument in the southern hemisphere. Without the Great Telescope another thirty years might have elapsed without producing changes sufficiently great to be within the compass of ordinary observatories.

Ignorant then of Mr. Le S.'s third sketch, and diffident of describing and drawing what I saw from the mere magnitude of the changes which had appeared in so short a time, I made a rapid sketch of the nebular portion of the lemniscate and neighbourhood, only putting in such stars as were necessary to guide the eye. The gulf at 634 *H* was one of the first features sketched, and my drawing shews not only that this star is in mid-channel, but that 616 *H* also is left nearly clear of nebula. The promontory which Mr. Le S.'s second sketch shews still remaining, has detached its extremity to form an island of nebula, in which I note a star-like nucleus, and this, with the remnant of the promontory, seems to direct itself still more towards the opposing cape, which, however, does not appear so prominent as in Sketch 2. This, and the neighbouring parts of this margin of the lemniscate appears to keep the same hard definite outline which is presented by Sir J. H. but at $1\frac{1}{2}$ *p* 3′=side of each square, $1\frac{1}{2}$ *N*, the outline seems encroaching upon the lemniscate, and leaving a little nearer *η* an oval patch of thinner nebula than that which surrounded it. Southwards also, the nebulous outline seems to be curdling and breaking up, and is evidently much less dense than drawn by H., and a little less so than drawn by Le S.

But in the *N p* loop of the lemniscate changes perhaps still more evident are going on. The outline preceding *H* 670, which in *Sketch* 1 largely bulged into the lemniscate to meet the isthmus, and which in *Sk.* 2 and *Sk.* 3 is slowly withdrawing itself, has still further retracted in a *N p* direction; the outline *p* this is withdrawing also in a *N p* direction, and two condensations are taking place in the faint nebula which fills the *N p* loop of the lemniscate. The curved *N p* arm of the V shaped appendage has turned itself into a *N* and *S* direction, and both arms appear straighter than in *Sk's* 1 and 2. A faint branch of nebula also appears $1\frac{1}{2}$ *N* of *η*, and proceeds in *a f* direction, giving an appearance

again approaching nearly to that drawn by H. in 1838. The very faint nebula *S p η*, does not appear at all until 2′ dist. where the outline of the faint nebula now seems to commence. The outlying portions preceding lemniscate also show slight changes, but to these I have not devoted so close an attention, deeming it better to keep a close and unremitting watch over the central portions, than to distract the mind with too great a variety of details, and what I have sketched, however carefully, I confirm by verbal description in my notes on the spot, and add any impressions, however trivial, which strike me at the time, as such impressions are sometimes found to prove of the greatest value in retrospect.

On the 17th January, of this year, I note: Power 520 shows distinct nebulosity surrounding *η* itself much condensed towards *η* chiefly in direction of lemniscate. The margins of the channels and lemniscate come out in good distinct relief, just as I have already sketched them; the vacant spaces showing almost black.

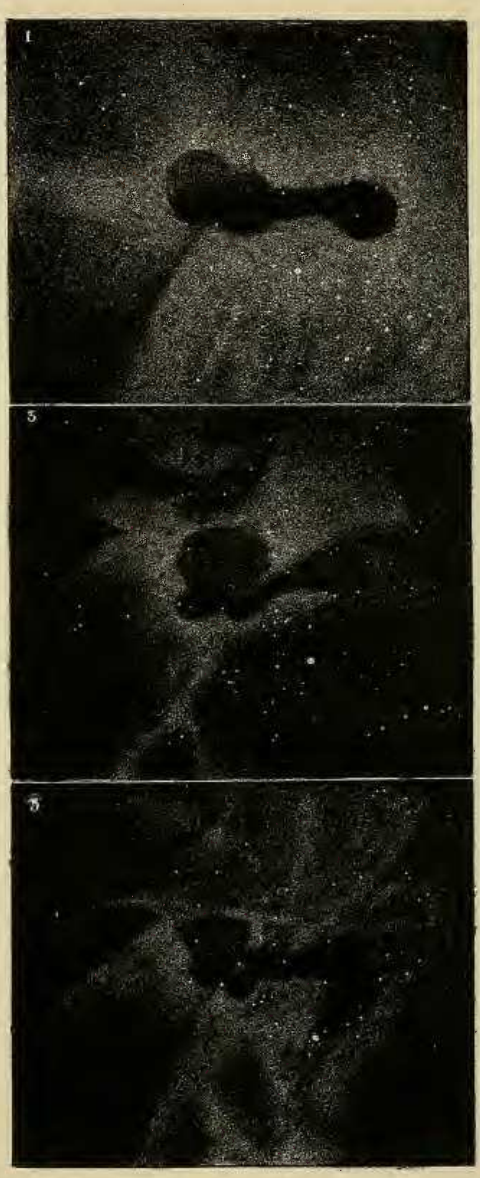
Spectrum of nebula very faint, with usual lines ghostly and fitful.

Spectrum of *η* hazy and unsatisfactory, with diffused light, although other stars appear distinct enough. Could not see the slightest appearance of bright lines, but fancied I detected with wide slit absorption bands in position of nebular lines, but too chaotic and indistinct for measurement although attempted frequently.

Can *η*'s light be absorbed by surrounding nebula? At the time Le Sueur observed (December 1869), he says, "No nebula is apparent about *η*, although sky did not appear so black as in lemniscate spaces, and *η* gave *bright* lines."

Next evening (18th January) Mr. Ellery confirmed my observations and verified sketch. Neither he nor Professor Smith, who was also present, *recognised* the spectrum of *η* when shown in the telescope as the same which they had seen the year before, and could find no bright lines. I again imagined I saw the same ghosts of absorption lines in the positions of the usual bright lines of the nebula.

On the 18th May my notes describe the appearance of a small star in the oval space *N. p. η* before described (owing to the nebula becoming still thinner in that spot) forming the head-star to a sort of miniature Orion of minute stars: a pentagon enclosing seven stars, *five* of which were seen by Le Sueur, *none* by H. The notes then proceed: "The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